ORTHODONTIC PRODUCTS	. 4
NEW PRODUCT DEVELOPMENT ACTIVITIES Erro	nr!
BRACKETS / BUCCAL TUBES	
Alexander Spirit BRACKETS	
SELF LIGATING BRACKET	. 4
BURSTONE Orthos CUSPID BRACKET with HORIZONTAL TUBE	
TOOTH SHAPED PAD	
TAKEMOTO LINGUAL APPLIANCE	
BANDS	
TEXTURED MOLAR_BANDS	
INTRA ORAL	
MOLDED Mini-Stick Power Os	
LOW COST RPE	
Orthos LIP BUMPER	
MANDIBULAR ANTERIOR REPOSITIONING APPLIANCE (Dr. Eckhart)	
D.O. MANDIBULAR WIDENING DEVICE	
<u>INSTRUMENTS</u>	
FLUSH CUT DISTAL-END CUTTER	
<u>ADHESIVES</u>	
THICK LIGHT CURE ADHESIVE - Enlight	. 8
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	. 8
BRACKETS / BUCCAL TUBES	. 8
Orthos CM F in Spirit MB	
Custom R, CUSTOM LABIAL APPLIANCE SYSTEM	
ADHESIVE PRECOAT BRACKETS	
TITANIUM BRACKET	
TITANIUM BUCCAL TUBE - MIM PROCESS.	
Wildman LINGUAL BRACKET	
SINGLE-PIECE BRACKET	
BANDS	
TITANIUM BANDS	
WIRE	
TITANIUM ALLOY WIRE	
GOLD ARCHES	
REVERSE-CURVE Copper Ni-Ti ARCHWIRES	
INTRA ORAL	
ORMCO CLASS II JUMPER	
IMPROVED POWER CHAIN	
EXTRA ORAL	
WEDGE-SHAPED NECK STRAP	
SUPPLIES / DISPENSING SYSTEMS.	
UNI-BRACKET PACKAGING	
ARCH MEASURING TEMPLATE	
ADHESIVES.	
MOISTURE-RESISTANT ADHESIVE	
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INSTRUMENTS	
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MATERIAL RESEARCH	

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### ORMCO CONFIDENTIAL AND PROPRIETARY INFORMATION

PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	16
IMPROVED OPTIMESH	16
IMPROVED OPTIMESHCE MARKING	16
BRACKET PLACEMENT IMPROVEMENT AOA (LABORATORY) ENGINEERING SUPPORT	17
AOA (LABORATORY) ENGINEERING SUPPORT	Error!
AEZ / ETM INSTRUMENT SUPPORT CUSTOM BRAZE	16
CUSTOM BRAZE	<i>I7</i>
ENDODONTIC PRODUCTS	17
NEW PRODUCT DEVELOPMENT	17
Post Remover Kit EIE Endo	17
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	18
Buchanan HAND PLUGGER	18
MISCELLANEOUS DEPARTMENT_ACTIVITIES	18
CAPITAL APPROPRIATION REQUESTS	18
PRODUCTS CURRENTLY ON INACTIVE STATUS	18

OR	TH	ODO:	NTIC	PRC	DU	CTS

#### RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

#### BRACKETS / BUCCAL TUBES

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

- Lab Reopening (Craig Andreiko)
  - Accomplishments / Status
    - ✓ Scanned image of the PK Thomas Case lower Jaw
    - Created new software modules to calculate the set-up of the lower jaw: the mandibular skeletal bone can be defined by the operator along with the mesio-distal width of the lowers 7x7, using photographic recomposition of the scanned model.
    - Successfully printed upper bracket tree (3 samples) and had them setup for casting.
  - 2) Goals For October
    - ☐ Implement new modules in the set-up programs to create the mandibular set-up and adapt the occlusion with the maxillary set-up.
       ☐ Test the casting process of the bracket trees.
    - ☐ Test the casting process of the bracket trees.☐ Manufacture the new jigs with the new attachment.
    - Assemble the upper case, using casted brackets and new jigs.
    - Major Project Milestone
      - Dower/Uppers Setup for the PK Thomas case: November 97
- b. 3D Digitizing (Eric Chapoulaud)

3)

- 1) Accomplishments / Status
  - No Action this month.
- 2) Goals For October
  - ☐ A malpositioned case will be scanned to be used as test data with the new set-up software being developed.
- 3) Major Project Milestone
  - First Clinical case scan: November 97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - Accomplishments / Status
    - Software upgrade of the ModelMaker II Driver was installed, along with modifications in the parameters file. It improved jet reliability and parts quality.
  - 2) Goals For October
    - ☐ Print parts to check for accuracy and reliability.

- 3) Major Project Milestone
  - Reliable printing operation: October 97.



# TRAVEL REQUEST

DATE:	July 11th, 1996	
TRAVELER:	Eric CHAPOULAUD - R&D	_
TRAVEL DATES:	July 25, 96 to July 28, 96	
TOTAL FARE:	\$ 533.00	

DATE	AIRLINE CARRIER	DEPARTURE CITY	ARRIVAL CITY	TIME OF DEPARTURE	TIME OF ARRIVAL
July 25th, 96	Amer.Airllines	L.A. (LAX)		8:00 AM	
		Boston			4:34 PM

July 28th, 96	Amer.Arilines	Boston		8:30 AM	
			L.A. (LAX)		11:26 AM

### **APPROVAL**

DEPARTMENT HEAD: BUSINESS UNIT VICE PRESIDENT:	
DECLINED	/COMMENTS

Prepared By:

# TRAVEL REQUEST MULTIPLE DESTINATIONS

7/29/96

Date:

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Gray: Please READ

Date: November 6, 1996
From: Fric CHAPOULAUD

To: Albert RUIZ-VELA, Craig ANDREIKO,
Dan EVEN

(c):

SANDERS Prototype: Wax printing Device Evaluation Visit

Since a few months, Craig ANDREIKO and myself have been evaluating 3D Solid freeform manufacturing devices that could be connected to our *ELAN* application and able to manufacture directly customized brackets. The technology currently available offers different type of materials among them photo-polymerisable (Stereo-lithography) and wax (3D plotting), and more important for our application, low resolution and accuracy except for the Model-maker 3D plotting device manufactured by SANDERS prototypes Inc.

Currently, the SANDERS **Model Maker** machine is the only one that can reach our accuracy needs: < 0.001 inch by offering the possibility of a 0.0005 inch resolution. We have conducted some tests with the west coast distributor by having him manufacturing parts that were created with our CAD software, and further with our new ELAN application software. The results have been promising in respect to the general aspect of the wax parts "plotted" and the dimensions as well. We have good hopes that this machine would allow us to manufacture customized brackets.

Nonetheless, we think that our application is sufficiently outside of the usual utilization of such machine that we have been advised by the local distributor that we should meet with the manufacturer in New Hampshire in order to point out the specifics of our application and discuss with him modifications and optimization possibilities in regard to our process. This meeting took place in WILTON N.H. on November 1st 1996, involving E. CHAPOULAUD for ORMCO and Mr MACINTYRE (National Sales V.P.), WIGAND (Technical Development), <<Chris>>> (Customer Support) and Mrs COLLINS (Training) for SANDERS Prototype. The Object of the meeting was to discuss our specific needs and the machine characteristics with <u>Application and development engineers</u>, discuss some interface problems and solutions, as well as communication between our software application and the software that drives the machine with <u>software development engineers</u> and discuss the <u>training aspects</u> for our in house operator.

#### 1) SANDERS Prototype Inc.:

This company has been created two years ago on the basis of patents on a wax printing technology, to develop and commercialize a "3D Plotting System" that is named "Model Maker<sup>TM</sup>". It currently employs 50 people and has shipped over 80 Model Maker machines (each machine is listed at \$60 000), which is its only commercialized product.

They are located in WILTON N.H. (small town in the outskirts of NASHUA N.H. about 60 miles north of BOSTON). Its President is Mr Anthony FINIZZIO. The medical supply company BAXTER recently acquired a 20 % stake of SANDERS (Contact at BAXTER is: Paul DIPERNA (847) 270 5502).

### 2) Model Maker: Desktop 3D Modeling System

Their product presents itself as a desktop unit that supports the CAD designer's workstation environment, allowing designers the ability of creating a physical 3D Model from their CAD design. This machine uses the same technology used in "inkjet printers" adapted to deposit thermo-wax droplets in successive layers allowing the build of 3D Objects from ground up. As we said above, our interest in this technology relies on their ability to use small layers (0.0005 in or 5 tenth of thousands of an inch, 12.5 micrometers) to create the 3D model. This machine is the only machine currently marketed that allows such small layers.

On a software point of view, this machine is usually connected to a PC Computer running a specific application program developped by SANDERS. This program uses ".STL" files as inputs. These type of files

From: Eric CHAPOULAUD

1

can be created by most of the CAD programs, including SolidWorks, from their own geometry format. The Sanders program can also accept other formats which will be discussed further. The ".STL" file is first "sliced" into a number of layers representing each layer's perimeter of material. Then these layers are used to create the jet-heads travel paths that will construct the 3D model. This machine operates as a inkjet printer that fills the contours representing the layers. Using well known software technology, it moves the let heads in straight lines between each end of the contours. filling up the inside of the perimeter of layers.

In order to produce accurate layer depths, the machine deposit more wax than necessary, waits for the wax to cool and uses a cutter to cut off the excess material. On the positive side, this process allows the machine to be able to produce layer thicknesses down to 5 tenth, but it also gives a slow process since cooling waiting time becomes a big factor in the model manufacturing time.

Since each layer of Wax need to be deposited on "something" to construct the model, Model Maker deposit a layer of another material to be used as support for counter-parts in the model. This material is also Wax, but has a lower melting point temperature, that allows this support material to be removed after the model is built. A cleaning phase is then necessary in order to have the finished Wax part. Please refer to the documents in annex for more information.

This machine has been marketed for almost a year, and customers reaction and comments have lead Sanders into upgrading the **Model Maker** to a new version that will be available in 8 months from now according to their National sales V.P. This machine, called "**Model Maker** II", shows improvement in mainly three aspects: Speed improvement in the Jet Heads Motion and head's wax delivery rate, Reliability and Speed improvement by air conditionning the printing space, Usability improvement by improving the building space to 12 x 6 x 9 inches against 6 x 6 x 6 inches for the current machine. According to Sanders, they are working on improving their material as well. In fact the new machine includes Higher temperature Wax-jets, allowing the possibility of stronger build material along with a better separation with the support material. This machine will be presented at AutoFact 96 in Chicago (November 11 to 16) as a beta version.

The current version of the machine is priced at \$59 900, while the new machine will priced at \$64 900. Sanders proposes the possibility of ordering the new machine as of now. Sanders will deliver the current version at the current price and when the new version is ready (June 97), it will be installed for an additionnal \$10 000.

#### 3) Characteristics and Specifications

>> See with Rob Connelly (Users Group)

#### 4) Training and Operation

With the purchase of the machine, a training session is offered for 2 or 3 people for a duration of 2 days. It includes training on the software and hands on the machine parameters. Sanders suggested that this training can be extended for another day allowing future users to work on their own parts, getting usefull suggestions and advises directly on their type of models.

The software is relatively easy to use, specially to an operator familiar with 2D/3D CAD design programs. The software works on any platform (Windows 3.1, Windows 95 or Windows NT). The new version that I was demonstrated is simpler than before and provides the operator with fewer options, for a less confusing environment. The current control software works with DOS, but does not involve any experience on DOS

Everybody at Sanders stressed upon that experience is the key of success in using their machine. Our operator would have to run lots of different parts and orientation in order to be very familiar to the machine behavior and produce good parts with sufficient repeatability and reliability. This machine needs to be taken good care of since it involves a lot of moving parts and "messy" wax drops.

Last month, a first meeting of a new **User's group** was held. This group is set aside Sanders influence while Sanders welcomes the initiative. This group is organized to share information and experience about **Model Maker**. This is most certainly a mine of information our operator could use.

#### 5) Application development Toolkit

From: Eric CHAPOULAUD

Date: 6-Nov-96

Sanders Model Maker machine is usually used as a peripheral of a CAD workstation, allowing designers to "print" a 3D model of the part they design. On the other hand, we think that we can use this machine to manufacture small quantities of brackets (ie: new products for clinical tests) and further, use the Model Maker machine to manufacture customized brackets along with the Elan program. Using the 3D Modeler, we can design a software that creates completely the brackets, according to the particular dimensions of each tooth, and send these design to the Wax printer to create a master to use to cast the finished part. This is a new and specific application for Sanders.

After discussion with John WIGAND (Technical Development), Sanders was interested in extracting a librairy of functions from their current program. This librairy would allow us to use their machine as a new device in our program, keeping our User interface. Our software would be able to launch the printing of the parts and get a status of execution. We also decided that ".STL" files was not a good interface between our softwares. We were supported by Al HASTBACKA in that direction. We would send "sitce files" to the librairy, since our software already has all the informations to extract the slices. We agreed with Sanders that we should put interface specifications on a joint document, so as to avoid confusion during the development. We proposed Sanders assistance in that specific development by spending some time with them while testing the interfaces. A "white paper" presenting different options should be composed by Sanders and sent to us.

### 6) Tests: One piece Brackets

While going over the new software version at Sanders, we have been able to manufacture a sample of two different one piece brackets that were designed by us. These parts are the most complex parts that we have asked Sanders to make. Most particularly, their pads includes a collection of little "pegs" of  $0.015 \times 0.015$  inches. These are very little details that are correctly reproduced by the machine.

Jurface finish can be Improved by laying down less material.

#### Conclusion:

The Sanders **Model Maker** is a very ingenious machine that performs correctly when the design is appropriate and should be able to maintain our tolerances (± 0.001 inch). The Wax parts produced are fragile but are not intended to be used as such: they will be used as masters for casting. Operation wise, **Model Maker** is easy to handle and its software is in coutinuous progress. It is essential with this machine that our future operator is well trained and maintain the machine correctly. The current version of the machine seems to be very sensitive to its environment (heat, vibration ...) while the next version could be faster and more reliable if we believe Sanders claims.

Sanders is a small company but is easy to contact and its people are very customer oriented. A good support is to be expected from this company, since this machine and its technology is relatively new on the market.

As far as cost of operation, this machine has a very good benefit since the material used (wax) is cheap, and the machine can work unattended so the operator cost is low. The material is provided only through Sanders while it actually does not manufacture the wax.

Fric CHAPOULAUD

From: Eric CHAPOULAUD

Date: 6-Nov-96

# 

Project Title: Elan 3-D Jigs (Project #853)

Prepared By: Eric Chapoulaud / Martha Lomelli

Date Prepared: November 6, 1996

#### A. SUMMARY

This request is for the purchase of a Desktop 3D modeling system to be used along with our  $\dot{E}lan$  customized appliance system. The ability to directly produce 3D wax master models from the computer design will allow  $\dot{E}lan$  to create full customization including the Pad shape for example. This machine will also be connected to our 3D CAD modeling system SolidWorks, as a rapid prototyping peripheral. This will allow our design team to obtain a 3D physical model of new product design within a few hours, or create small batches of parts to use in clinical tests. The total investment will be \$76.900.

#### B. EXISTING SITUATION

Contemporary orthodontic prescriptions rely primarily on norms and principles developed by Dr. Andrews. Individual preferences of leading practitioners have created modifications that form the basis of the prescriptions which clutter the orthodontic marketplace today. Ormco's *Élan* program, has employed sophisticated computer hardware and software to re-examine the existing appliances and techniques, and design a more systematic, state of the art orthodontic appliance system (brackets, molar tubes, archwires and jigs).

In the existing  $\dot{E}lan$  system, we use "Vanilla" brackets preforms that are positioned in a milling machine where the final characteristics of the customized bracket are cut into position (Torque and Rotation In Slot, if necessary). This involves two steps as manufacturing has to produce "Vanilla" brackets batches and a second phase of characterization will be performed in our laboratory. While this technique has been proved adequate for the current system, it cannot be improved to add further customization, in the Pad shape, dimension and adhesion surface for example. Moreover, with our current system it is very complex to implement customization for lingual appliances, since not only we need to adapt the torque but also the InOut. Most specifically, since our designs evolve into one picce brackets, the Pad design becomes completely related to the bracket design for labial as well as for lingual appliances.

These new design constraints have led us into switching our CAD software capabilities from 2D to true 3D modeling, in recently investing into 4 SolidWorks CAD workstation seats (CAR # D-0196). Although this new system provides us with nice viewing capabilities of our 3D model designs, it would be sometimes very useful to be able to produce a real model representing the design so as to

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### WAR GIVE STRUCKEY

Project Title:

Elan 3-D Jigs (Project #853)

Prepared By:

Eric Chapoulaud / Martha Lomelli

Date Prepared:

November 6, 1996

verify functionality and scale of our very small parts. Most often, we need to sct up small batches of parts of our new design to send to our clinicians for clinical tests purpose. The current method involves setting up R&D temporary tooling and manufacturing process to produce such batches, and therefore has a tooling and labor cost.

#### C. PROPOSED SOLUTION

We believe that the Élan appliances, when properly used as an integrated system, will provide more effective and efficient orthodontic treatment, at lower cost and with measurably better outcomes in every aspect that is important to both orthodontist and patient. Along with our investigating clinicians, we also think that Élan system will gain better accuracy and quality if completely customized

Our new Élan software provides us the ability to automatically create 3D CAD bracket designs from a set of parameters such has Torque, RIS and also size and shape (Diamond angle). It will be further improved to allow complete customization of the Pad for example. While investigating methods of manufacturing to be used with this feature, we have evaluated rapid prototyping equipments that produce 3D models directly from 3D designs. After different feasibility tests, we have singled out the Model Maker machine manufactured by Sanders Prototype Inc. (Wilton N.H.). This machine has the capabilities to produce Wax models with a tolerance of +/- 0.0005 inches that can be used as investment casting patterns. This machine provides software to process CAD files and produce the wax representation of the model. It is possible to link this machine's software to ours so that we can produce almost automatically fully customized bracket designs. In order to produce the final part, we would cast the wax patterns, using standard techniques that we know well.

The Model Maker machine can be connected to our 3D CAD workstations as a rapid prototyping peripheral. This device uses standard CAD formats and produces wax patterns within our tolerances and in a sufficiently short time. It can operate unattended, at night for example.

### D. INVESTMENT REQUIRED and RETURN ON INVESTMENT

The Model Maker II cost is \$ 64,900 for the new version that will be available in June 1997. Sanders Prototype proposes a deal that includes delivery of the current version of the machine at the current price \$ 59,900 and a switch to the new version when available for an additional \$



Project Title: Elan 3-D Jigs (Project #853)

Prepared By: Eric Chapoulaud / Martha Lomelli

Date Prepared: November 6, 1996

15,000. Two days of training are included in the price. Support is free for the first year (Additional years of maintenance can be bought for \$ 6000).

We believe that this machine represents an opportunity for us to step forward in the direction of completely customized appliances that could not be possible in a cost effective way otherwise, for labial and lingual appliance as well. Model Maker from Sanders will also allow us to reduce our new product development costs by shortening our development process during the new product design phase. by having the in-house possibility of verifying functionality and tolerances on real models, costly design errors can be corrected at the design phase instead of after the pre-production phase. Such a machine reduces delays in bringing new products to the market, by reducing the number of iterations during the development and the pre-production phase. Finally, it gives us a definitely cheaper and faster way of producing small batches of new products that can be used for clinical tests.

#### E. RISKS and OPPORTUNITIES

During the evaluation of this machine, we have performed a number of tests that have been successful. We have created a 3D CAD design using our 3D Modeling workstation and have been able to create a wax pattern for investment casting within our tolerance specifications. We also have been testing successfully the possibility of producing customized brackets designed with our *Élan* software. Tolerances were also correctly observed. Although the Model Maker from Sanders is a new technology that will certainly improve in the future, we believe that this machine is presently able to produce parts that fit our needs.

#### F. RISK MANAGEMENT

A visit to Sanders facilities was able to show confidence in their ability to train and support new customers. Their software has been continuously improved for more user friendly functions and reliability. The new version of the machine available next year will improve speed, reliability and pattern material.

#### G. ALTERNATIVES

One possible alternative is to "do-nothing". This means that the *Élan* system will continue to produce parts through a two step process. From "Vanilla" brackets the design of which is costly and

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Project Title: Elan 3-D Jigs (Project #853)

Prepared By: Eric Chapoulaud / Martha Lomelli

Date Prepared: November 6, 1996

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difficult to change. It also means that we would not be able to rapidly test new products at the design phase or at the clinical test phase.

Our evaluation of the rapid prototyping offers at the moment showed that no other machine is able to produce our small parts within our tolerances. Our visit at Sanders demonstrated their commitment into solving our specific needs for the *Élan* system. They are able to set-up more strict specifications for us during their manufacturing process so that our machine would have even better tolerances. Finally Sanders offers the least expensive solution currently marketed for rapid prototyping.

### H. INVESTMENT BREAKDOWN

An investment of \$76,900 will be required to acquire the Model Maker II machine from Sanders Prototype Inc. Pending shipment of the Model Maker II unit (Spring '97), a MM6-PRO (as quoted) will be installed for our use. When Model Maker II is available, Sanders Prototype will then replace the interim unit, intall the new machine, and restart a 12 months warranty. Details of the capital investment are as follows:

#### CAPITAL:

1.	ModelMaker Unit	\$ 59,900
2.	Spare Printhead (Build and Support)	\$ 1,000
3.	MM6-PRO Interim program	\$ 15,000
	TOTAL	\$ 76.900

Ormco EXHIBIT G

### Interoffice Memorandum

From: Albert Ruiz-Vela

Date: January 3, 1997

To: Dan Even

Subject: Monthly Report - December 1996

Product Development & Engineering

cc: Mark Clineff

Glenn Lyon

Ernie Strauch Mark Vigna

Eckhard Vogel

Craig Andreiko

Kerry Darney

Tony Elie

Al Ezcurra

Farrokh Farzin-Nia

H.R. Ghalambor

Mark Payne

Tom Selkee

Hamid Sheikh

Raymond Thornton

Ray Wong

Harry Yawata

Lourdes Lara

Adriana Navas

Larry Phaneuf

Ron Sirney

Jim Warren

Corinne Pantaleo

Eric Chapoulaud

Dan Dixon

Ted Driefuss

Colin Matheson

John Payne

Brian Hulan

Henry Hulan

Don Frei

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### TABLE OF CONTENTS

A. NEW PRODUCT DEVELOPMENT ACTIVITIES	2
TYPE I (Built In-House)	Error!
AI-1. Alexander Spirit Brackets	Error!
AI-2. Self-Ligating Brackets (Dr. Wildman)	Error!
AI-3. Pre-formed Quick Nance Appliance (Dr. Hilgers)	Error!
AI-4. Alexander Flat Bow Retainer Wires with Omega Loops	Error!
AI-5. Spirit MB Expansion	Error!
AI-6. Cantilever Crown Anchorage System (Dr. Mayes)	Error!
AI-7. Disposable Metal Impression Tray	Error!
AI-8. AEZ Instruments	Error!
a. Titanium Bird Beak Pliers	Error!
b. Flush-Cut Distal-End Cutter	Error!
AI-9. Textured Molar Bands	Error!
AI-10. Orthos Accent Buccal Tubes	Error!
AI-11. Orthos CM Buccal Tubes	Error!
AI-12. File Bender	Error!
AI-13. Nanda Facebow	Error!
AI-14. Gold Brackets	Error!
AI-15. Burstone Orthos Cuspid Brackets with Horizontal Tube	Error!
AI-16. Pre-formed Palatal Arch Appliance (Dr. Burstone)	Error!
AI-17. Rapid Palatal Expanders	Error!
AI-18. Molded Power Os	Error!
TYPE II (Outside Vendor)	Error!
TYPE III (Product Modifications)	Error!
III-1. Alternative Braze Material	Error!
III-2. Spirit Bracket Material	Error!
B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	Error!
TYPE I (Built In-House)	Error!
B1-1. Orthos-AD Alexander Discipline Appliance System	Error!
B1-2. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System	Error!
BI-3. CustomR, Custom Labial Appliance System	2
BI-4. CustomR <sub>x</sub> Custom Lingual Appliance System	Error!
BI-5. Adhesive Pre-Coated Brackets	Error!
BI-6. Metal Slot Ceramic Brackets	Error!
BI-7. Mandibular Anterior Repositioning Appliance (Dr. Eckhart)	Error!
BI-8. Moisture-Resistant Adhesive	Error!
BI-9. Wedge-Shaped Neck Strap (Dr. Alexander)	Error!
BI-10. Orthos CM F in Spirit MB	Error!
BI-11. Orthos Adjustable Placement Gauge	Error!
BI-12. Orthos AD in Spirit MB	Error!
BI-13. Aluminum Bracket	Error!
BI-14. Ni-Ti Ligaturless Bracket	Error!
BI-15. Bite Turbo Bracket	Error!
BI-16. Tooth Shaped Pad	Error!
BI-17. Titanium Brackets	Error!
BI-18. Titanium Buccal Tubes	Error!
BI-19. Titanium Bands	Error!

D. OTHER DEPARTMENT ACTIVITIES

Error!

DII. Capital Appropriation Requests

Error!

DIII. Bond Toughness Impact Tester

DI. Documentation

### A. <u>NEW PRODUCT DEVELOPMENT ACTIVITIES</u>

- BI-3. CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E HR Ghalambor / Eric Chapoulaud)
  - b. 3D Digitizing (Eric Chapoulaud)
    - 1) Accomplishments / Status
      - Specified and built Reference sphere for view-melting protocol. Defined a Standard sphere with grooves for calibration check.
      - Calibration of the Scanner using these elements. The scanner can be aligned and calibrated within 10 microns, insuring very accurate view-melting.
    - 2) Goals For January
      - ☐ Calibration Protocol: Implement the automatic view-melting method in the Calibration program (Background task).
        - Calibrate the second sensor.
      - Develop interfacing program allowing set-up of the scanning procedure using the global sensor and user defined views.
    - 3) Major Project Milestones
      - Bite registration manufacturing: February 1996.
- DIII. BOND TOUGHNESS IMPACT TESTER (Project 959; Craig Andreiko / Eric Chapoulaud)
  - a. Accomplishments / Status
    - ☑ No test done this month.
  - b. Goals For January

П

- ☐ No Test to be done
- c. Major Project Milestones
  - No major milestones.

Ormco EXHIBIT H

### Interoffice Memorandum

cc:

From: Albert Ruiz-Vela Date: February 7, 1997

To: Dan Even Subject: Monthly Report - January 1997

Product Development

& Engineering

Mark Clineff Glenn Lyon Mark Vigna Eckhard Vogel Don Frei

Craig Andreiko Kerry Darney Al Ezcurra Farrokh Farzin-Nia Gary Garman Randy Hacker

Randy Hacker Jason Lee Mark Payne Tom Selkee Hamid Sheikh Raymond Thornton Ray Wong

Lourdes Lara Larry Phaneuf Ron Sirney Jim Warren

Corinne Pantaleo Eric Chapoulaud

**Bob Davis** 

Dan Dixon Ted Driefuss Grace Kibler Colin Matheson John Payne Brian Hulan Henry Hulan

Tom McCarthy Joe Rotino Mary Warren ORMCO CONFIDENTIAL

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### TABLE OF CONTENTS

ORTHODONTIC PRODUCTS	4
A. NEW PRODUCT DEVELOPMENT ACTIVITIES	4
TYPE I (Built In-House)	4
AI-1. Alexander Spirit Brackets	4
AI-2. Self-Ligating Brackets (Dr. Wildman)	4
	4
	5
	5
11-14. Oratos Esp Bumper	8
TYPE II (Outside Vendor)	8
NEW PRODUCT DEVELOPMENT ACTIVITIES   4	
B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	8
TYPE I (Built In-House)	8
BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System	8
	9
BI-19. Wildman Lingual Bracket	
BI-20. Arch Measuring Template	
BI-21. Takemoto Lingual Appliance	15
BI-22. Single-Piece Bracket	15
BI-23. Titanium Alloy Wire	15
B1-24. Power Chain Dispensing System	16
BI-25. Occlusally Offset Molar Pads	16

AI-1. Post Remover Kit

AI-2. Buchanan Hand Plugger

22

22

### **ORTHODONTIC PRODUCTS**

#### B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

1	<u> Y</u>	ľ	Ł	Ţ	(R	uil	t	m-r	10	use)	)

ГҮРЕ :	<u>I</u> (Buil	t In-House)
BI-2.		mR <sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric pulaud)
	a.	Lab Reopening (Craig Andreiko)
		1) Accomplishments / Status  ☑  ☑  ☑
		2) Goals For February
		3) Major Project Milestones
		Lab will reopen once 3D scanning and jig fabrication is completed.
	b.	3D Digitizing (Eric Chapoulaud)
		1) Accomplishments / Status  ☑ Due to the power outage during the wind-storm at the beginning of the month, the scanner computer failed. A new single board pentium based computer is now at the core of the scanner. This new configuration introduced hardware modifications on the reset function of the computer, and power-up protection have been set-up to avoid the motion axis to crash at power-up.  ☑ Th upgrade in processing power allows us to scan 3 times faster without changing the software. The scanner is now operational.  2) Goals For February  ☐ Upgrade the software librairies to provide faster scans.  ☐ Acquire new scans of upper and lower dentition.  ☐ Modify the Acquisition software to provide easier to use interface and more flexibility on the programming side.  ☐ Manufacture a bite registration using the newly acquired scans.  3) Major Project Milestones  ⑤ Bite registration manufacturing: February 1996.
BI-3.	Custo	omR <sub>x</sub> CUSTOM LINGUAL APPLIANCE SYSTEM (Project 953-E; Craig Andreiko)
	a. b.	Accomplishments / Status  ☑  ☑  ☑  ☑  ☑  ☑  ☑  ☑  ☑  Goals For February
	υ.	

- c. Major Project Milestone
  - Re-evaluate project once 3D scanning & jig fabrication is completed.

Ormco EXHIBIT I

### InterofficeMemorand.m

Albert Ruiz-Vela From:

Date: March 7, 1997

To: Dan Even Subject: Monthly Report - February 1997

**Product Development** 

& Engineering

Mark Clineff cc:

Glenn Lyon Mark Vigna Eckhard Vogel

Don Frei Craig Andreiko

Kerry Darney Farrokh Farzin-Nia Gary Garman Randy Hacker Jason Lee

Mark Pavne Tom Selkee Hamid Sheikh

Raymond Thornton

Ray Wong Ron Sirney

Eric Chapoulaud

**Bob Davis** Dan Dixon Ted Driefuss Grace Kibler Colin Matheson John Payne

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### TABLE OF CONTENTS

ORTHODONTIC PRODUCTS	4
A. NEW PRODUCT DEVELOPMENT ACTIVITIES	4
TYPE I (Built In-House)	
AI-1. Alexander Spirit Brackets	4
AI-2. Self-Ligating Brackets (Dr. Wildman)	4
AI-3. Alexander Flat Bow Retainer Wires with Omega Loops	4
AI-4. AEZ Instruments	4
a. Flush-Cut Distal-End Cutter	5
AI-5. Textured Molar Bands	5
AI-6. Burstone Orthos Cuspid Brackets with Horizontal Tube	5
AI-7. Molded Mini-Stick Power Os	5
AI-8. Bite Turbo Bracket	6
AI-9. Tooth Shaped Pad	6
AI-10. Orthos-AD Alexander Discipline Appliance System	6
AI-11. Mandibular Anterior Repositioning Appliance (Dr. Eckhart)	7
AI-12. Low Cost RPE	7
AI-13. Orthos Carriere Bracket	7
AI-14. Orthos Lip Bumper	8
AI-15. Orthos Weldable Bicuspids	8
TYPE II (Outside Vendor)	8
TYPE III (Product Modifications)	8
	· ·
B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	8
TYPE I (Built In-House)	8
TYPE I (Built In-House) BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System	<b>8</b> 8
TYPE I (Built In-House)	<b>8</b> 8 9
TYPE I (Built In-House) BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System	<b>8</b> 8 9 9
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System  BI-2. CustomR, Custom Labial Appliance System  BI-3. CustomR, Custom Lingual Appliance System	<b>8</b> 8 9 9
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander)	8 8 9 9 10
TYPE I (Built In-House) BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB	<b>8</b> 8 9 9
TYPE I (Built In-House) BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge	8 8 9 9 10 10
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB	8 8 9 9 10 10 10
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket	8 8 9 9 10 10 10 11 11
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket	8 8 9 9 10 10 10 11 11
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets	8 8 9 9 10 10 10 11 11 11
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Buccal Tubes	8 8 9 9 10 10 10 11 11 11 11 12
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM. F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Brackets BI-13. Titanium Brackets BI-14. Titanium Bands	8 8 9 9 10 10 10 11 11 11 12 12 12 12
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Bracket BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research	8 8 8 9 9 9 100 100 110 111 111 112 122 122 13 13 13 13
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging	8 8 8 9 9 9 100 100 111 111 112 122 122 133 133 133 133 133
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-T1 Ligaturless Bracket BI-12. Titanium Bracket BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormco Class II Jumper	8 8 8 9 9 9 10 10 10 11 11 11 12 12 12 12 13 13 13 13 14
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormco Class II Jumper BI-18. Wildman Lingual Bracket	8 8 8 9 9 9 100 100 110 111 111 122 122 123 133 133 134 14 14
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Brackets BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormco Class II Jumper BI-18. Wildman Lingual Bracket BI-19. Arch Measuring Template	8 8 8 9 9 9 100 110 110 111 111 112 122 122 123 133 133 144 144 144 144
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos Adjustable Placement Gauge BI-9. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormco Class II Jumper BI-18. Wildman Lingual Bracket BI-19. Arch Measuring Template BI-20. Takemoto Lingual Appliance	8 8 8 9 9 9 10 10 10 10 11 11 11 12 12 12 12 13 13 13 14 14 14 14 15
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos AD in Spirit MB BI-19. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormeo Class II Jumper BI-18. Wildman Lingual Bracket BI-19. Arch Measuring Template BI-20. Takemoto Lingual Appliance BI-21. Single-Piece Bracket	8 8 8 9 9 9 10 10 100 11 1 11 11 12 12 12 12 13 13 13 14 14 14 15 15 15
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Brackets BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormco Class II Jumper BI-18. Wildman Lingual Bracket BI-19. Arch Measuring Template BI-20. Takemoto Lingual Appliance BI-21. Single-Piece Bracket BI-22. Titanium Alloy Wire	8 8 8 9 9 9 100 100 110 111 111 112 122 122 133 133 134 144 145 155 155 15
TYPE I (Built In-House)  BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System BI-2. CustomR, Custom Labial Appliance System BI-3. CustomR, Custom Lingual Appliance System BI-4. Adhesive Pre-Coated Brackets BI-5. Moisture-Resistant Adhesive BI-6. Wedge-Shaped Neck Strap (Dr. Alexander) BI-7. Orthos CM_F in Spirit MB BI-8. Orthos AD in Spirit MB BI-19. Orthos AD in Spirit MB BI-10. Aluminum Bracket BI-11. Ni-Ti Ligaturless Bracket BI-12. Titanium Brackets BI-13. Titanium Buccal Tubes BI-14. Titanium Bands BI-15. Material Research BI-16. Uni-Bracket Packaging BI-17. Ormeo Class II Jumper BI-18. Wildman Lingual Bracket BI-19. Arch Measuring Template BI-20. Takemoto Lingual Appliance BI-21. Single-Piece Bracket	8 8 8 9 9 9 10 10 100 11 1 11 11 12 12 12 12 13 13 13 14 14 14 15 15 15

Product Development & Engineering Report	Eebruary 1997	Page 3	
ORMCO CONFIDENTIAL A	ND PROPRIETARY INFO	RMATION	
BI-25. Improved Power Chain	·		16
BI-26. Gold Arches			16
BI-27. MARA Three Jaw Plier			17
BI-28. MARA Torque Tool			17
TYPE II (Outside Vendor)			17
BII-1. Reverse-Curve Copper Ni-Ti Archwires			17
BII-2. Disinfectant Solution			18
BII-3. Titanium Buccal Tube - MIM Process			18
C. PRODUCT IMPROVEMENT / MANUFACTUR	RING SUPPORT ACTIVITI	ES	18
C-I. AOA (Laboratory) Engineering Support			18
C-II. CE Marking			19
C-III. Bracket Placement Process Improvement			20
C-IV. Gold Bracket Alternative Vendor			20
C-V. AEZ / ETM Instrument Support			20
C-VI. Improved Optimesh			20
D. OTHER DEPARTMENT ACTIVITIES			21
D-I. Capital Appropriation Requests			21
D-II. Custom Braze			21

**ENDODONTIC PRODUCTS** 

AI-1. Post Remover Kit

AI-2. Buchanan Hand Plugger

A. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

21

21

21

22

### **ORTHODONTIC PRODUCTS**

#### B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

TYPE I (Built In-House)

- BI-2. CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)
  - a. Lab Reopening (Craig Andreiko)
    - 1) Accomplishments / Status
      - ☑ Completed a first draft of a schedule leading to 5 clinical cases using 3D Jigs
    - 2) Goals For March
      - ☐ Review the plan draft.
    - 3) Major Project Milestones
      - To be set according to the plan review
  - b. 3D Digitizing (Eric Chapoulaud)
    - 1) Accomplishments / Status
      - ☑ 3D Scanning of the upper jaw of a P.K THOMAS model.
      - Developed functions in the model acquisition application to position brackets on the scanned teeth. Using the STL files from Spirit brackets, an appliance was set-up on the P.K. THOMAS model, and the corresponding wire was mathematically computed.
    - 2) Goals For March
      - According to the plan draft, we will create a Set-up application allowing us to manually position wires, brackets and tube and calculate the corresponding appliance on the P.K. THOMAS upper model.
      - ☐ Manufacture the Brackets and the wire
      - ☐ Start the bracket attachment and tooth registration part of the 3D Jig
    - 3) Major Project Milestones
      - To be set according to the plan review: (3D Jig Design Review: May 1997).
- BI-3. CustomR<sub>x</sub> CUSTOM LINGUAL APPLIANCE SYSTEM (Project 953-E; Craig Andreiko/Eric Chapoulaud)
  - a. Accomplishments / Status
  - b. Goals For March
  - c. Major Project Milestone
    - Re-evaluate project once 3D scanning & jig fabrication is completed.

**Ormco** EXHIBIT J

### Interdfice/Ventrandum

From: Albert Ruiz-Vela Date: April 8, 1997

To: Dan Even Subject: Monthly Report - March 1997

Product Development & Engineering

cc: Mark Clineff

Glenn Lyon Mark Vigna Eckhard Vogel Don Frei

Craig Andreiko Kerry Darney Farrokh Farzin-Nia Gary Garman Randy Hacker Jason Lee Mark Payne Tom Selkee Hamid Sheikh Raymond Thornton

Ray Wong Ron Sirney Eric Chapoulaud

Bob Davis Dan Dixon Ted Driefuss Grace Kibler Colin Matheson John Payne

Brian Hulan Henry Hulan Steve Paskin Eric Shirley

Tom McCarthy Joe Rotino Mary Warren ORMCO CONFIDENTIAL

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March 1997

### TABLE OF CONTENTS

ORTHODONTIC PRODUCTS	4
A. NEW PRODUCT DEVELOPMENT ACTIVITIES	4
TYPE I (Built In-House)	4
AI-1. Alexander Spirit Brackets	4
AI-2. Self-Ligating Brackets (Dr. Wildman)	4
AI-3. AEZ Instruments	4
a. Flush-Cut Distal-End Cutter	4
AI-4. Textured Molar Bands	5
AI-5. Burstone Orthos Cuspid Brackets with Horizontal Tube	5
AI-6. Molded Mini-Stick Power Os	5
AI-7. Tooth Shaped Pad	6
AI-8. Orthos-AD Alexander Discipline Appliance System	6
AI-9. Mandibular Anterior Repositioning Appliance (Dr. Eckhart) AI-10. Low Cost RPE	7
AI-10. Low Cost RPE AI-11. Orthos Carriere Bracket	7
AI-11. Otthos Carriere Blacket AI-12. Orthos Lip Bumper	7
AI-12. Orthos Weldable Bicuspids	7
·	
TYPE II (Outside Vendor)	8
TYPE III (Product Modifications)	8
B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	8
TYPE I (Built In-House)	8
BI-1. Orthos-AD/AP Alexander Discipline Asian Prescription Appliance System	8
BI-2. CustomR <sub>x</sub> Custom Labial Appliance System	8
BI-3. CustomR <sub>x</sub> Custom Lingual Appliance System	9
BI-4. Adhesive Pre-Coated Brackets	9
BI-5. Moisture-Resistant Adhesive	10
BI-6. Wedge-Shaped Neck Strap (Dr. Alexander)	10
BI-7. Orthos CM_F in Spirit MB	10
BI-8. Orthos Adjustable Placement Gauge	11
BI-9. Orthos AD in Spirit MB	11 11
BI-10. Ni-Ti Ligaturless Bracket BI-11. Titanium Brackets	11
BI-12. Titanium Brads	12
BI-13. Material Research	12
BI-14. Uni-Bracket Packaging	12
BI-15. Ormco Class II Jumper	13
BI-16. Wildman Lingual Bracket	13
BI-17. Arch Measuring Template	13
BI-18. Takemoto Lingual Appliance	14
BI-19. Single-Piece Bracket	14
BI-20. Titanium Alloy Wire	14
BI-21. Power Chain Dispensing System	14
BI-22. Occlusally Offset Molar Pads	15
BI-23. Improved Power Chain	15
BI-24. Gold Arches	15
BI-25. MARA Three Jaw Plier	16
BI-26. MARA Torque Tool	16

TYPE II (Outside Vendor) BII-1. Reverse-Curve Copper Ni-Ti Archwires	16
BII-2. Disinfectant Solution	16 17
BII-3. Titanium Buccal Tube - MIM Process	17
C. PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	17
C-I. AOA (Laboratory) Engineering Support	17
C-II. CE Marking	18
C-III. Bracket Placement Process Improvement	18
C-IV. Gold Bracket Alternative Vendor	19
C-V. AEZ / ETM Instrument Support	19
C-VI. Improved Optimesh	19
D. OTHER DEPARTMENT ACTIVITIES	20
D-I. Capital Appropriation Requests	20
D-II. Custom Braze	20
ENDODONTIC PRODUCTS	20
A. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	20
AI-1. Post Remover Kit	20
AI-2. Buchanan Hand Plugger	20

### ORTHODONTIC PRODUCTS

### B. RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

TYPE I (Built In-House)

BI-2.	CustomRx CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eri
	Chapoulaud)

a.	Lab	Reopening (Craig Andreiko / Eric Chapoulaud)
	1)	Accomplishments / Status
		A Plan describing the activity for this project has been written and submitted for approval. It intends to allow us to produce 5 clinical cases in the next six months using the new 3D JIGS, that will be clinically tested in a closeby office.
		According to this plan, a case of 5x5 for the uppers of the PK Thomas model has been manually designed: Wire and Brackets position and characteristics. A new appliance design software (codename Atlantis) was created allowing the tooth long axis definition and Wire design.
	2)	Goals For April
		☐ Design of the 3D JIG tooth regsistration surface component.
		☐ Design of the 3D JIG bracket attachment component.

Manufactruing of the 3D JIGS for the 5x5 uppers of the PK Thomas Model.

- ☐ Implementation of the corresponding software.

  3) Major Project Milestones
  - © 3D JIG Design review: 5/15/97
- b. 3D Digitizing (Eric Chapoulaud)

П

1) Accomplishments / Status

☑ No development were implemented this month.

- 2) Goals For April
  - ☐ No new development anticipated this month.
- 3) Major Project Milestones
  - Mandibular jaw of the PK Thomas model scanned: 5/18/97.

### BI-3. CustomR<sub>r</sub> CUSTOM LINGUAL APPLIANCE SYSTEM (Project 953-E; Craig Andreiko)

- a. Accomplishments / Status
  - ☑ No development were implemented this month.
- b. Goals For April
  - ☐ No new development anticipated this month.
- c. Major Project Milestone
  - Re-evaluate project once 3D scanning & jig fabrication is completed.

### Ormco

### Interoffice/Memorandum

From: Albert Ruiz-Vela

Date: May 9, 1997

To: Dan Even

Subject: Monthly Report - April 1997

**Product Development** 

& Engineering

cc: Mark Clineff

Glenn Lyon Mark Vigna Eckhard Vogel Steve Tomassi Dan Dixon Brian Hulan

Farrokh Farzin-Nia

Mark Payne

Henry Hulan

Raymond Thornton

Ray Wong

Bob Davis Ted Driefuss Grace Kibler Colin Matheson Steve Paskin Tom McCarthy Joe Rotino

Mary Warren

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ORTHODONTIC PRODUCTS	4
NEW PRODUCT DEVELOPMENT ACTIVITIES	4
BRACKETS/BUCCAL TUBES	4
Alexander Spirit BRACKETS	4
Orthos-AD ALEXANDER APPLIANCE DISCIPLINE SYSTEM	
Orthos CARRIERE BRACKET	
SELF LIGATING BRACKET	
BURSTONE Orthos CUSPID BRACKET with HORIZONTAL TUBE	
TOOTH SHAPED PAD.	
Orthos WELDABLE BICUSPIDS	
TAKEMOTO LINGUAL APPLIANCE	
BANDS.	
TEXTURED MOLAR BANDS	
INTRA ORAL	
MOLDED Mini-Stick Power Os	
LOW COST RPE	
Orthos LIP BUMPER	
MANDIBULAR ANTERIOR REPOSITIONING APPLIANCE (Dr. Eckhart)	
INSTRUMENTS.	0
FLUSH CUT DISTAL-END CUTTER	
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	
BRACKETS / BUCCAL TUBES	
Orthos CM_F in Spirit MB	8
Custom R <sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM	
ADHESIVE PRECOAT BRACKETS	
TITANIUM BRACKET	
TITANIUM BUCCAL TUBE - MIM PROCESS	
Wildman LINGUAL BRACKET	
SINGLE-PIECE BRACKET	
BANDS	
TITANIUM BANDS	
WIRE	
TITANIUM ALLOY WIRE	
GOLD ARCHES	
REVERSE-CURVE Copper Ni-Ti ARCHWIRES	
INTRA ORAL	
ORMCO CLASS II JUMPER	
IMPROVED POWER CHAIN	
EXTRA ORAL	
WEDGE-SHAPED NECK STRAP	
SUPPLIES / DISPENSING SYSTEMS	
UNI-BRACKET PACKAGING	
ARCH MEASURING TEMPLATE	
ADHESIVES	
MOISTURE-RESISTANT ADHESIVE	
<u>INSTRUMENTS</u>	
Orthos ADJUSTABLE PLACEMENT GAUGE	
MARA THREE-JAW PLIER	
MARA TORQUE TOOL	
MISCELLANEOUS	
MATERIAL RESEARCH	I 5
BRODUCT IMBROVENEST IMANUEL CHURNO CURRODE LOTHUTES	

IMPROVED OPTIMESH GOLD BRACKET ALTERNATIVE VENDOR	
GOLD BRACKET ALTERNATIVE VENDOR	
CE MARKING	
BRACKET PLACEMENT IMPROVEMENT	
AOA (LABORATORY) ENGINEERING SUPPORT	17
AEZ / ETM INSTRUMENT SUPPORT	
CUSTOM BRAZE	18
ENDODONTIC PRODUCTS	18
NEW PRODUCT DEVELOPMENT	18
Post Remover Kit EIE Endo	
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	19
Buchanan HAND PLUGGER	
MISCELLANEOUS DEPARTMENT_ACTIVITIES	19
CAPITAL APPROPRIATION REQUESTS	19
PRODUCTS CURRENTLY ON INACTIVE STATUS	10



#### RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

- a. Lab Reopening (Craig Andreiko)
  - 1) Accomplishments / Status
    - ☑ Following the 6 months plan, the 5x5 PK Thomas Case has been created: We have manually designed a wire the fits the case and obtained bracket characteristics (Torque, In/Out and RIS). The wire was milled using a Stainless-steel plate (0.021).
    - A new Jig design software was created, using the scanned images and the tooth definition (Long Axis and Section). As a result a first Jig was produced for the upper right cuspid, with correct precision. A prototype mounting was done by bonding the Jig to a bracket with a wire attachment part. This set produced an acceptable fit and positioning precision.
    - ☑ Jig fit problems have been identified for the upper right lateral.
  - Goals For May
    - Improving the Jig design and manufacturing precision particularly for the Central and lateral.
    - Creation of a 5x5 case of Jigs.
  - 3) Major Project Milestones
- b. 3D Digitizing (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - No development was taken this month.
  - Goals For May
    - No development anticipated this month.
  - 3) Major Project Milestones
    - Mandibular jaw of the PK Thomas model scanned: 6/22/97.

Ormco EXHIBIT L

#### Interoffice Menorandum

From: Albert Ruiz-Vela

Date: June 10, 1997

To: Dan Even

Subject: Monthly Report - May 1997

& Engineering

**Product Development** 

cc: Mark Clineff

Glenn Lyon Mark Vigna Eckhard Vogel Steve Tomassi Dan Dixon Brian Hulan Henry Hulan

Farrokh Farzin-Nia

Mark Payne

Raymond Thornton

Ray Wong
Bob Davis
Ted Driefuss
Grace Kibler
Colin Matheson
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ORTHODONTIC PRODUCTS	
NEW PRODUCT DEVELOPMENT ACTIVITIES	••••
BRACKETS / BUCCAL TUBES	
Alexander Spirit BRACKETS	
Orthos-AD ALEXANDER APPLIANCE DISCIPLINE SYSTEM	
Orthos CARRIERE BRACKET	
SELF LIGATING BRACKET	
BURSTONE Orthos CUSPID BRACKET with HORIZONTAL TUBE	
TOOTH SHAPED PAD	
Orthos WELDABLE BICUSPIDS	
TAKEMOTO LINGUAL APPLIANCE	
BANDS	
TEXTURED MOLAR_BANDS	
INTRA ORAL	
MOLDED Mini-Stick Power Os	
LOW COST RPE	
Orthos LIP BUMPER	
MANDIBULAR ANTERIOR REPOSITIONING APPLIANCE (Dr. Eckhart)	
INSTRUMENTS	
FLUSH CUT DISTAL-END CUTTER	
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	8
BRACKETS / BUCCAL TUBES	,
Orthos CM F in Spirit MB	
Custom R <sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM	
ADHESIVE PRECOAT BRACKETS	
TITANIUM BRACKET	
TITANIUM BUCCAL TUBE - MIM PROCESS	11
Wildman LINGUAL BRACKET	- 11
SINGLE-PIECE BRACKET	11
BANDS	16
TITANIUM BANDS	11
WIRE	1.1
TITANIUM ALLOY WIRE	1.
GOLD ARCHES	1.
REVERSE-CURVE Copper Ni-Ti ARCHWIRES	1.
INTRA ORAL	11
ORMCO CLASS II JUMPER	1.
IMPROVED POWER CHAIN	12
EXTRA ORAL	10
WEDGE-SHAPED NECK STRAP	1:
SUPPLIES / DISPENSING SYSTEMS	12
UNI-BRACKET PACKAGING	12
ARCH MEASURING TEMPLATE	12
ADHESIVES	13
MOISTURE-RESISTANT ADHESIVE	13
INSTRUMENTS	13
MARA THREE-JAW PLIER	13
MARA TORQUE TOOL	13
MISCELLANEOUS	13
MATERIAL RESEARCH	13
PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	1.

IMPROVED OPTIMESH	11
IMPROVED OPTIMESHCE MARKING	14
RRACKET DI ACEMENT IMPROVEMENT	
AOA (LABORATORY) ENGINEERING SUPPORT	15
AEZ / ETM INSTRUMENT SUPPORT	15
AOA (LABORATORY) ENGINEERING SUPPORT  AEZ / ETM INSTRUMENT SUPPORT  CUSTOM BRAZE	16
ENDODONTIC PRODUCTS	
NEW PRODUCT DEVELOPMENT	16
Post Remover Kit EIE Endo	16
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	
Buchanan HAND PLUGGER	
MISCELLANEOUS DEPARTMENT_ACTIVITIES	
CAPITAL APPROPRIATION REQUESTS	17
PRODUCTS CURRENTLY ON INACTIVE STATUS	17

1 3 4 3 4

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# ORTHODONTIC PRODUCTS

# RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

CustomRx CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

- Lab Reopening (Craig Andreiko)
  - 1) Accomplishments / Status
    - ☑ Improvement of the JIG Design for the Upper Lateral: Modification of the lingual surface to remove interferences, Modication of the manufacturing software to improve precision of the milling paths.
    - Improvement of the visualization software: Modification of the sections functionnality to allow easier debugging of the Jig design and manufacturing software.
    - 2) Goals For June
      - ☐ Improve the Jig design and manufacturing for the Upper Lateral Jig.
        ☐ Creation of 5x5 case of Jigs
    - Creation of 5x5 case of Jigs.
       Major Project Milestones
      - 3D JIG Design review: 6/30/97
- b. 3D Digitizing (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - No development was done this month.
  - 2) Goals For June
    - □ No development is anticipated this month.
  - 3) Major Project Milestones
    - Mandibular jaw of the PK Thomas model scanned: 6/22/97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - Reception and Set-up of the Wax patterns manufacturing machine from SANDERS prototype Inc: "Model Maker Pro".
    - Produced wax parts of Upper Lateral brackets in different sizes: real life, scale 10 and currently scale 20.
    - During the parts manufacturing, we have been adjusting the machine parameters to our labaoratory conditions and to our parts size, shape and accuracy.
  - 2) Goals For June
    - ☐ Training at SANDERS for E. Chapoulaud and L. Phaneuf.
    - ☐ Continue adjusting parameters of the machine for better precision and reliability
    - ☐ Produce customized wax patterns of brackets and JIGS, using the Elan Software.
  - 3) Major Project Milestones

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**Ormco** EXHIBIT M

### InterdficeMemorandum

From: Albert Ruiz-Vela

Date: July 21, 1997

To: Dan Even

Subject: Monthly Report - June 1997

**Product Development** 

& Engineering

cc: Mark Clineff

Glenn Lyon

Mark Vigna Eckhard Vogel Steve Tomassi Dan Dixon Brian Hulan Henry Hulan

Farrokh Farzin-Nia

Mark Payne

Raymond Thornton

Ray Wong

Bob Davis Ted Driefuss Grace Kibler Colin Matheson Steve Paskin

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BRACKETS / BUCCAL TUBES	Error!
Alaxandar Spirit RDACKETS	4
Orthos, AD ALEXANDER APPLIANCE DISCIPLINE SYSTEM	
Orthos CARRIERE BRACKET	
SELF LIGATING BRACKET	5
RURSTONE Orthos CUSPID BRACKET with HORIZONTAL TUBE	5
TOOTH SHAPED PAD	
Orthos WELDARLE RICUSPIDS	
TAKEMOTO LINGUAL APPLIANCE	6
BANDS	6
TEXTURED MOLAR BANDS.	6
INTRA ORAL	6
MOLDED Mini-Stick Power Os	
LOW COST RPE	
Orthos LIP BUMPER	
MANDIRI JAR ANTERIOR REPOSITIONING APPLIANCE (Dr. Eckhart)	7
INCTDUMENTS	8
FLUSH CUT DISTAL-END CUTTER	8
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	8
BRACKETS / BUCCAL TUBES	8
Orthos CM F in Spirit MR	č
Custom R <sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM	8
ADHESIVE PRECOAT BRACKETS	9
TITANIUM BRACKET	
TITANIUM BUCCAL TUBE - MIM PROCESS	
Wildman LINGUAL BRACKET	10
SINGLE-PIECE BRACKET	10
BANDS	10
TITANIUM BANDS	IO
WIRE	11
TITANIUM ALLOY WIRE	1
GOLD ARCHES	1
REVERSE-CURVE Copper Ni-Ti ARCHWIRES	1.
INTRA ORAL	
ORMCO CLASS II JUMPER	
IMPROVED POWER CHAIN	IZ
EXTRA ORAL	12
WEDGE-SHAPED NECK STRAP	
SUPPLIES / DISPENSING SYSTEMS	
UNI-BRACKET PACKAGING	1.
ARCH MEASURING TEMPLATE	1
ADHESIVES	
MOISTURE-RESISTANT ADHESIVE	I
INSTRUMENTS	
MARA THREE-JAW PLIER	1
MARA TOROUF TOOL	
MISCELLANEOUS.	1
MATERIAL RESEARCH	I
PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	
PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	I

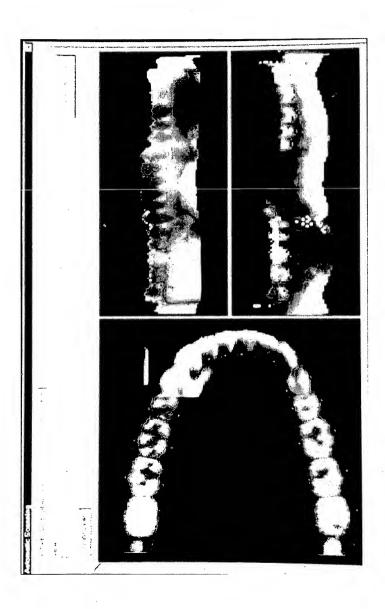
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CE MARKING	14
BRACKET PLACEMENT IMPROVEMENT	1
AOA (LABORATORY) ENGINEERING SUPPORT	1
AEZ / ETM INSTRUMENT SUPPORT	10
IMPROVED OPTIMESH CE MARKING BRACKET PLACEMENT IMPROVEMENT AOA (LABORATORY) ENGINEERING SUPPORT AEZ / ETM INSTRUMENT SUPPORT CUSTOM BRAZE.	11
NINO DO NINO DO NINO	
NDODONTIC PRODUCTS	
EW PRODUCT DEVELOPMENT	16
iEW PRODUCT DEVELOPMENT Post Remover Kit EIE Endo	16
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	
Buchanan HAND PLUGGER	13
IISCELLANEOUS DEPARTMENT_ACTIVITIES	17
CAPITAL APPROPRIATION REQUESTS	13
RODUCTS CURRENTLY ON INACTIVE STATUS	17

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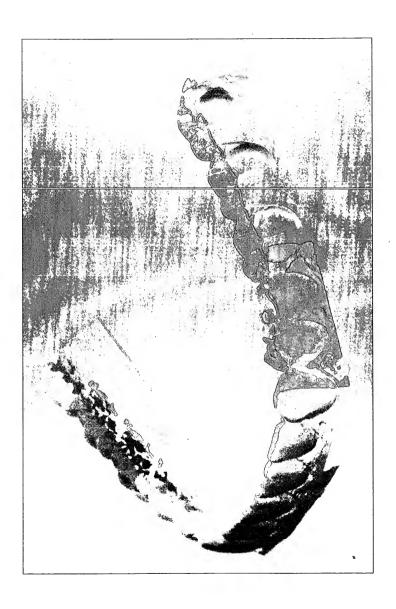
### RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

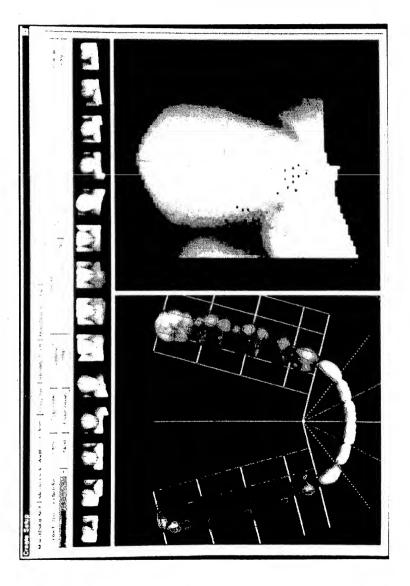
- a. Lab Reopening (Craig Andreiko)
  - 1) Accomplishments / Status
    - ☑ A set of 5x5 Jigs have been manufactured after accuracy improvement of the manufacturing software. These jigs have been manually mounted with to their respective brackets. This case reveals good fit accuracy to the model.
    - The next step is to attach the brackets to the jigs. For that purpose, we cannot easily use the old Elan vanilla brackets. We think that the attachment would be best with a cylindrical vertical slot. We have decided to create these brackets by software and use the Rapid prototyping machine to manufacture them.
    - Software modules to create brackets from the dimensions, torque, In/out and RIS was started from a previous prototype written in 1995.
  - 2) Goals For July
    - Improve the bracket design software and manufacture brackets with cylindrical vertical slot.
    - ☐ Creation of 5x5 case of Jigs and brackets.
  - 3) Major Project Milestones
    - Solution 3D JIG Design review: 8/31/97
- b. 3D Digitizing (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - ✓ No development was done this month.
  - 2) Goals For July
    - ☐ No development is anticipated this month.
  - 3) Major Project Milestones
    - Mandibular jaw of the PK Thomas model scanned: August 97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - ☑ Continued producing parts with the MM6 Pro.
  - 2) Goals For July
    - ☐ Training at SANDERS for E. Chapoulaud and L. Phaneuf.
    - Installation of the MMII, upgrade version of the MM6 Pro. Upgrade of the SANDERS software.
  - 3) Major Project Milestones
    - ര



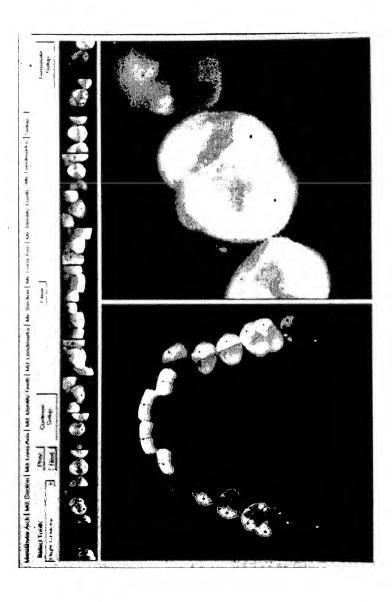
(Fig. 3A)



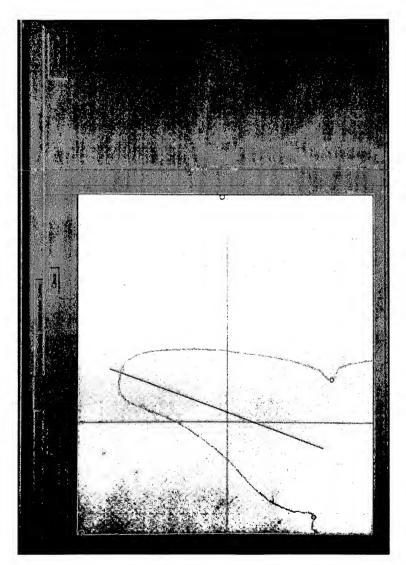
XHIBIT N



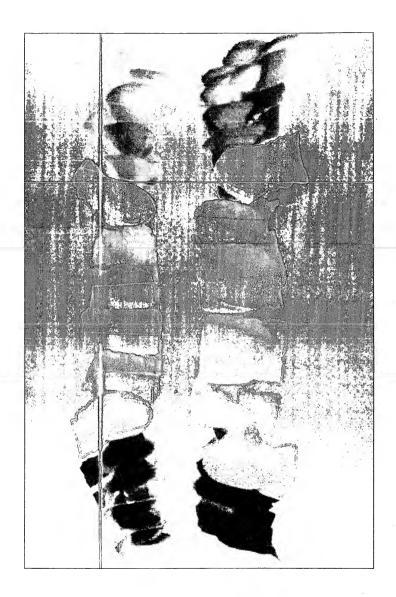
(Fig. 4)



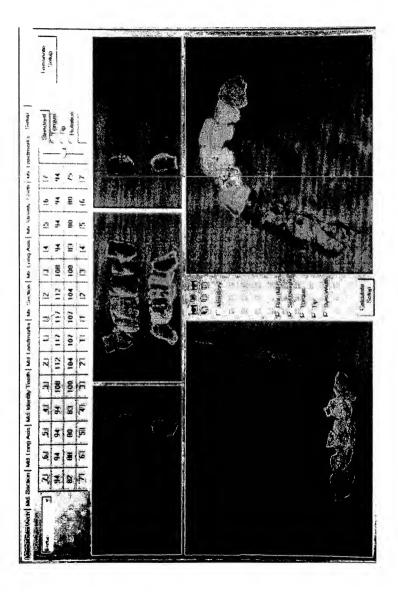
(Fig. 4B)



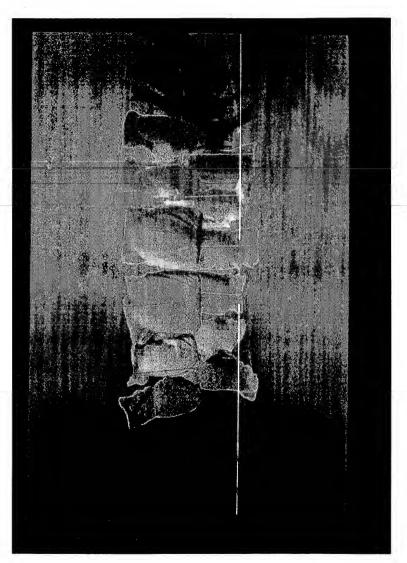
(Fig. 4C)



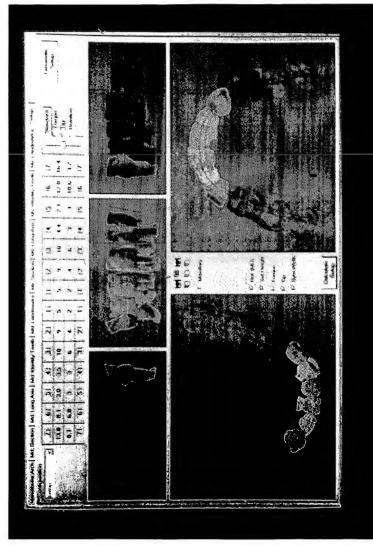
(Fig. 5)



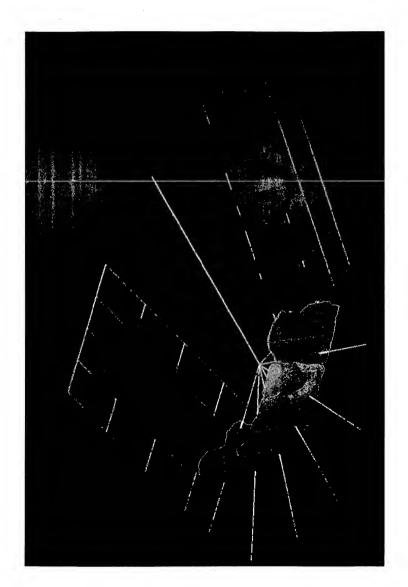
(Fig. 5A)



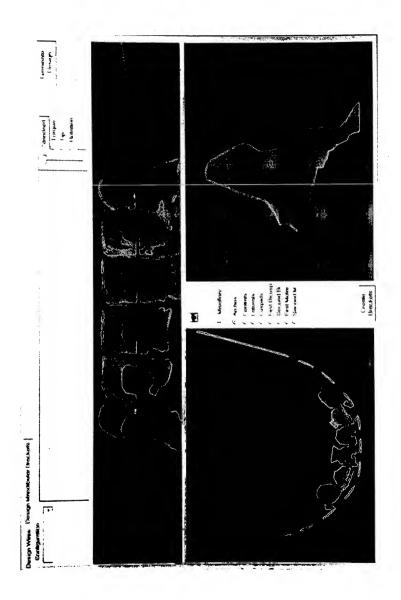
(Fig. 5B)



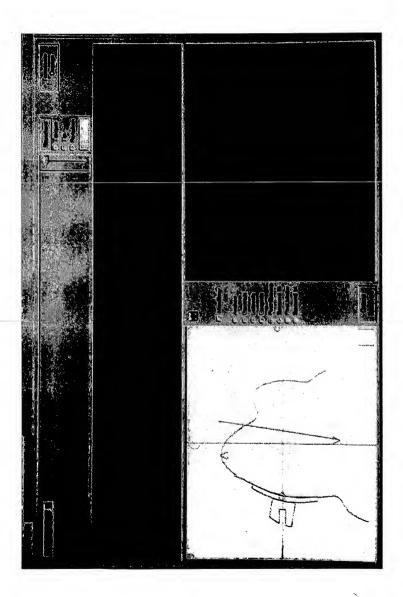
(Fig. 5C)



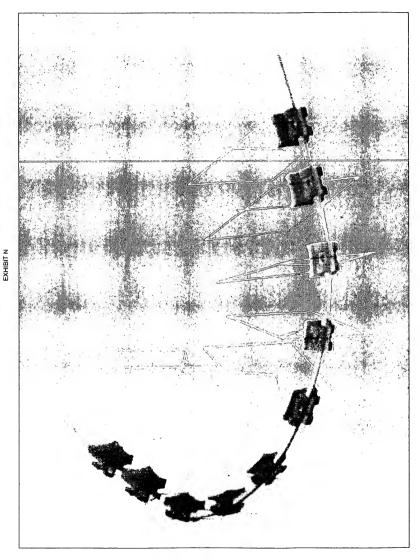
(Fig. 5D)

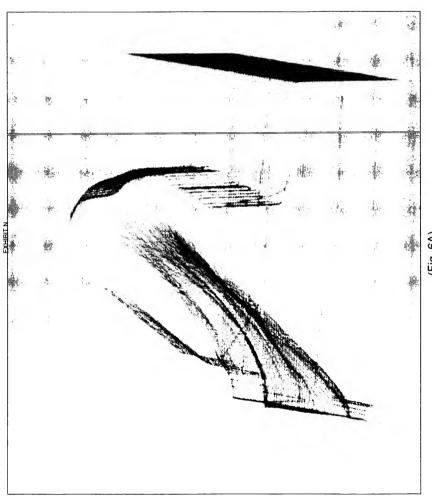


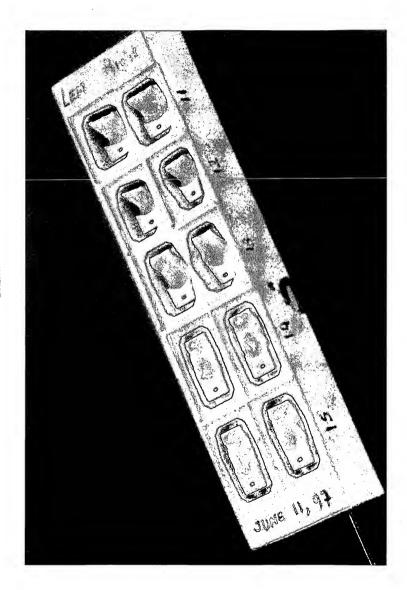
(Fig. 5E)



(Fig. 5F)







**EXHIBIT N** 

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**Ormco** EXHIBIT Q

#### Interoffice/Memorandum

From: Albert Ruiz-Vela Date: July 30, 1997

To: Dan Even Subject: Monthly Report - July 1997

Product Development

& Engineering

cc: Mark Clineff

Glenn Lyon Mark Vigna Eckhard Vogel Steve Tomassi Dan Dixon Brian Hulan Henry Hulan

Farrokh Farzin-Nia

Mark Payne

Raymond Thornton

Ray Wong

Bob Davis Ted Driefuss Grace Kibler Colin Matheson Steve Paskin Tom McCarthy

Joe Rotino
Mary Warren

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ORTHODONTIC PRODUCTS	
NEW PRODUCT DEVELOPMENT ACTIVITIES	
BRACKETS/BUCCAL TUBES	
Alexander Spirit BRACKETS	
Orthos-AD ALEXANDER APPLIANCE DISCIPLINE SYSTEM	
Orthos CARRIERE BRACKET	
SELF LIGATING BRACKET	
BURSTONE Orthos CUSPID BRACKET with HORIZONTAL TUBE	
TOOTH SHAPED PAD	
Orthos WELDABLE BICUSPIDS	
TAKEMOTO LINGUAL APPLIANCE	
BANDS TRYTUDES MOLED BANDS	
TEXTURED MOLAR_BANDS.	
INTRA ORAL	
MOLDED Mini-Stick Power Os LOW COST RPE	
Orthos LIP BUMPER	
MANDIBULAR ANTERIOR REPOSITIONING APPLIANCE (Dr. Eckhart)	
INSTRUMENTS.  FLUSH CUT DISTAL-END CUTTER.	
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	8
BRACKETS/BUCCAL TUBES.	8
Orthos CM F in Spirit MB.	
Custom R, CUSTOM LABIAL APPLIANCE SYSTEM	
ADHESIVE PRECOAT BRACKETS	9
TITANIUM BRACKET	
TITANIUM BUCCAL TUBE - MIM PROCESS	
Wildman LINGUAL BRACKET	
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BANDS	
TITANIUM BANDS	10
WIRE	1
TITANIUM ALLOY WIRE	1
GOLD ARCHES	<i>1</i> i
REVERSE-CURVE Copper Ni-Ti ARCHWIRES	1
INTRA ORAL	1
ORMCO CLASS II JUMPER	1
IMPROVED POWER CHAIN	12
EXTRA ORAL	
WEDGE-SHAPED NECK STRAP	12
SUPPLIES / DISPENSING SYSTEMS	12
UNI-BRACKET PACKAGING	
ARCH MEASURING TEMPLATE	12
ADHESIVES	
MOISTURE-RESISTANT ADHESIVE	13
INSTRUMENTS	
MARA THREE-JAW PLIER	13
MARA TORQUE TOOL	13
MISCELLANEOUS	
MATERIAL RESEARCH.	1.
PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	1,

Product Development & Engineering Report	EXHIBITALY 1997	Page 3
ORMCO CONFIDENTIAL A	ND PROPRIETARY INFO	ORMATION
IMPROVED OPTIMESH		
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BRACKET PLACEMENT IMPROVEMENT		I
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BRACKET PLACEMENT IMPROVEMENT.  AOA (LABORATORY) ENGINEERING SUPPORT  AEZ / ETM INSTRUMENT SUPPORT  CUSTOM BRAZE		
ENDODONTIC PRODUCTS		1
NEW PRODUCT DEVELOPMENT		
Post Remover Kit EIE Endo		1
RESEARCH AND EXPLORATORY PRODUCT INVEST	IGATIONS	
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## RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

- a. Lab Reopening (Craig Andreiko)
  - 1) Accomplishments / Status
    - Debugging of the bracket design software with cylindrical vertical slot.
    - A software module to automatically create a brackets tree for the 5x5 case was developed and tested with the SANDERS MM6 Pro machine. This software creates a '.STL' file from the Setup model file that contains the brackets models.
    - ☑ The Bracket design has been also improved to include constant pad thickness, lower gingival wing, rounded corners on the pad.
  - 2) Goals For August
    - Improve the brackets tree design, manufacture tree samples and cast them.
    - ☐ Creation of 5x5 case of Jigs and brackets.
  - 3) Major Project Milestones
    - 3D JIG Design review: 8/31/97
- b. 3D Digitizing (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - ☑ No development was done this month.
  - 2) Goals For August
    - □ No development is anticipated this month.
  - 3) Major Project Milestones
    - Mandibular jaw of the PK Thomas model scanned: August 97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - ☐ Training at SANDERS for E. Chapoulaud and L. Phaneuf was accomplished.
    - ☑ Installation of the MMI, upgrade version of the MM6 Pro. Intermittent problems on the building jet was discovered. A new jet will be sent by SANDERS to replace it.
    - Upgrade of the SANDERS Software.
  - 2) Goals For August
    - ☐ New Upgrade of the SANDERS software.
    - Installation of a Printer Server, that will be used as a Milling machine Server also.
  - 3) Major Project Milestones

@

**Ormco** EXHIBIT R

#### Interoffice Memorandum

From: Albert Ruiz-Vela Date: September 1, 1997

To: Dan Eyen Subject: Monthly Report - August 1997

Product Development & Engineering

cc: Mark Clineff

Glenn Lyon Mark Vigna Eckhard Vogel Steve Tomassi Dan Dixon Brian Hulan Henry Hulan

Farrokh Farzin-Nia

Mark Payne

Raymond Thornton

Ray Wong

Bob Davis Ted Driefuss Grace Kibler Colin Matheson Steve Paskin Tom McCarthy

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ORTHODONTIC PRODUCTS	
NEW PRODUCT DEVELOPMENT ACTIVITIES	
BRACKETS/BUCCAL TUBES	4
Alexander Spirit BRACKETS	
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REVERSE-CURVE Copper Ni-Ti ARCHWIRES	
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Product Development & Engineering Report EXHIBIT August 1997 ORMCO CONFIDENTIAL AND PROPRIETARY INFORMATION	Page 3
PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	— 16
IMPROVED OPTIMESH. CE MARKING. BRACKET PLACEMENT IMPROVEMENT. AOA (LABORATORY) ENGINEERING SUPPORT. AEZ / ETM INSTRUMENT SUPPORT. CUSTOM BRAZE	16 17 <b>Error!</b>
ENDODONTIC PRODUCTS	17
NEW PRODUCT DEVELOPMENT  Post Remover Kit EIE Endo	
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	18
Buchanan HAND PLUGGER	18
MISCELLANEOUS DEPARTMENT_ACTIVITIES	18
CAPITAL APPROPRIATION REQUESTS	18
PRODUCTS CURRENTLY ON INACTIVE STATUS	18

## ORTHODONTIC PRODUCTS



August 1997

### RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

#### BRACKETS / BUCCAL TUBES

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

- Lab Reopening (Craig Andreiko)
  - 1) Accomplishments / Status
    - ☑ The design software for custom brackets was implemented in the Setup software. A set of 10 brackets for the uppers 5x5 of the PK
      Thomas case was calculated. These developments were made
      necessary in order to attach the bracket to the jig, using real tip values,
      through a vertical cylindrical slot, which could not be done otherwise.
    - ☑ Software modules were added to our manufacturing program to automatically create a tree assembling the 10 brackets, and create a '.STL' file suitable for the Model Maker wax printer.
    - Attempt were made to print this tree with the new Model Maker II. Note: The vertical cylindrical slot has a diameter of 0.032 in. It was printed correctly and the support material could be removed easily from it without any manual operation.
  - 2) Goals For September
    - ☐ Create the Lower Jaw case using the newly scanned images.

      Implement new modules in the set-up programs to create the mandibular set-up and adapt the occlusion with the maxillary set-up.
    - ☐ Successfully print the upper brackets tree and cast it.
    - Manufacture the new jigs with the new attachment.
       Assemble the upper case, using casted brackets and new jigs.
  - 3) Major Project Milestone
    - 3D JIG Design Review: September 97
- b. 3D Digitizing (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - According to the plan, a 3D Scan of the PK Thomas case lower Jaw has been acquired, using existing software.
  - Goals For September
    - Scan a real clinical case using the same software.
  - 3) Major Project Milestone
    - © Clinical case scan: September 97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - 1) Accomplishments / Status

4

- A new Build jet and heated line was sent by Sanders to replace our failing one. After replacement, we have been able to print a tree without any significant problems.
- 2) Goals For September
  - ☐ Upgrade the model maker software.
  - Print parts to check for accuracy and reliability.
- 3) Major Project Milestone
  - Reliable printing operation: October 97.

ORTHODONTIC PRODUCTS	. 4
NEW PRODUCT DEVELOPMENT ACTIVITIES Erro	nr!
BRACKETS / BUCCAL TUBES	
Alexander Spirit BRACKETS	
SELF LIGATING BRACKET	. 4
BURSTONE Orthos CUSPID BRACKET with HORIZONTAL TUBE	
TOOTH SHAPED PAD	
TAKEMOTO LINGUAL APPLIANCE	
BANDS	
TEXTURED MOLAR_BANDS	
INTRA ORAL	
MOLDED Mini-Stick Power Os	
LOW COST RPE	
Orthos LIP BUMPER	
MANDIBULAR ANTERIOR REPOSITIONING APPLIANCE (Dr. Eckhart)	
D.O. MANDIBULAR WIDENING DEVICE	
<u>INSTRUMENTS</u>	
FLUSH CUT DISTAL-END CUTTER	
<u>ADHESIVES</u>	
THICK LIGHT CURE ADHESIVE - Enlight	. 8
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	. 8
BRACKETS / BUCCAL TUBES	. 8
Orthos CM F in Spirit MB	
Custom R, CUSTOM LABIAL APPLIANCE SYSTEM	
ADHESIVE PRECOAT BRACKETS	
TITANIUM BRACKET	
TITANIUM BUCCAL TUBE - MIM PROCESS.	
Wildman LINGUAL BRACKET	
SINGLE-PIECE BRACKET	
BANDS	
TITANIUM BANDS	
WIRE	
TITANIUM ALLOY WIRE	
GOLD ARCHES	
REVERSE-CURVE Copper Ni-Ti ARCHWIRES	
INTRA ORAL	
ORMCO CLASS II JUMPER	
IMPROVED POWER CHAIN	
EXTRA ORAL	
WEDGE-SHAPED NECK STRAP	
SUPPLIES / DISPENSING SYSTEMS.	
UNI-BRACKET PACKAGING	
ARCH MEASURING TEMPLATE	
ADHESIVES.	
MOISTURE-RESISTANT ADHESIVE	
LINGUAL RETAINER ADHESIVE	
ONE COMPONENT BAND CEMENT	
INSTRUMENTS	
MARA THREE-JAW PLIER	
MARA TORQUE TOOL	
MISCELLANEOUS.	
MATERIAL RESEARCH	

Product Development & Engineering Repor	t FYHIRIT'S September 1997
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3

PRODUCT IMPROVEMENT / MANUFACTURING SUPPORT ACTIVITIES	16
IMPROVED OPTIMESH	16
IMPROVED OPTIMESHCE MARKING	16
BRACKET PLACEMENT IMPROVEMENT AOA (LABORATORY) ENGINEERING SUPPORT	17
AOA (LABORATORY) ENGINEERING SUPPORT	Error!
AEZ / ETM INSTRUMENT SUPPORT CUSTOM BRAZE	16
CUSTOM BRAZE	<i>I7</i>
ENDODONTIC PRODUCTS	17
NEW PRODUCT DEVELOPMENT	17
Post Remover Kit EIE Endo	17
RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS	18
Buchanan HAND PLUGGER	18
MISCELLANEOUS DEPARTMENT_ACTIVITIES	18
CAPITAL APPROPRIATION REQUESTS	18
PRODUCTS CURRENTLY ON INACTIVE STATUS	18

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#### RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

#### BRACKETS / BUCCAL TUBES

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

- Lab Reopening (Craig Andreiko)
  - Accomplishments / Status
    - ✓ Scanned image of the PK Thomas Case lower Jaw
    - Created new software modules to calculate the set-up of the lower jaw: the mandibular skeletal bone can be defined by the operator along with the mesio-distal width of the lowers 7x7, using photographic recomposition of the scanned model.
    - Successfully printed upper bracket tree (3 samples) and had them setup for casting.
  - 2) Goals For October
    - Implement new modules in the set-up programs to create the mandibular set-up and adapt the occlusion with the maxillary set-up.
       Test the casting process of the bracket trees.
    - ☐ Test the casting process of the bracket trees.☐ Manufacture the new jigs with the new attachment.
    - Assemble the upper case, using casted brackets and new jigs.
    - Major Project Milestone
      - Dower/Uppers Setup for the PK Thomas case: November 97
- b. 3D Digitizing (Eric Chapoulaud)

3)

- 1) Accomplishments / Status
  - No Action this month.
- 2) Goals For October
  - ☐ A malpositioned case will be scanned to be used as test data with the new set-up software being developed.
- 3) Major Project Milestone
  - First Clinical case scan: November 97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - Accomplishments / Status
    - Software upgrade of the ModelMaker II Driver was installed, along with modifications in the parameters file. It improved jet reliability and parts quality.
  - 2) Goals For October
    - ☐ Print parts to check for accuracy and reliability.

- 3) Major Project Milestone
  - Reliable printing operation: October 97.

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### Interoffice Memorandum

From: Eric Chapoulaud Date: October 6, 1997

To: Albert Ruiz-Vela Subject: Monthly Report - September 1997

Product Development

& Engineering

INFORMATION -

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## ORTHODONTIC PRODUCTS

# RESEARCH AND EXPLORATORY PRODUCT INVESTIGATIONS

CustomR<sub>x</sub> CUSTOM LABIAL APPLIANCE SYSTEM (Project 853-E Craig Andreiko/Eric Chapoulaud)

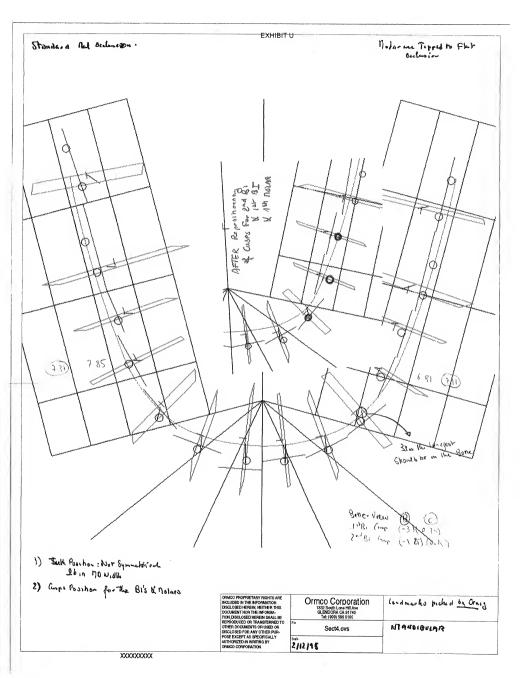
- a. Lab Reopening (Craig Andreiko)
  - 1) Accomplishments / Status
    - Our set-up program is now able to design the mandibular set-up, using scanned 3D images of the lower jaw.
    - Maxillary Case assembly was halted due to unreliable operation of the 3D wax printer. Priority was set to develop the set-up software.
  - Goals For November

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- Improve the set-up design rules using our new 3D approach, and verify these new rules with our PK Thomas case and the standard malpositionned case.
  - Adapt the appliance design software to the new set-up functions.
- ☐ Design and manufacture Jigs for the Mandibular set-up.
- ☐ Improve the teeth 3D modelisation for appearance and speed.
- 3) Major Project Milestone

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- Lower/upper setup for the PK Thomas case: November 97
- b. 3D Digitizing (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - No Action this month
    - A backslash problem was detected in the Z Axis of the scanner. A Newport technician was called upon to repair the axis.
  - 2) Goals For November
    - Reinstall the repaired Z axis. Realign the Z axis to the correct position.
    - ☐ Recalibrate the Scanner, using standard procedure.
    - Scan a standard mal-positionned case, to use as test data with the new set-up software being developed.
  - 3) Major Project Milestone
    - First Clinical case scan: November 97.
- c. Bracket Fabrication (Eric Chapoulaud)
  - 1) Accomplishments / Status
    - Hardware upgrade of the ModelMaker II was installed by Sanders.
    - Printed better quality parts.
    - ☑ Slicing Software upgrade for better reliability.
  - 2) Goals For November
    - ☐ Print and cast parts to improve the process.
  - 3) Major Project Milestone
    - Reliable printing operation: January 98.



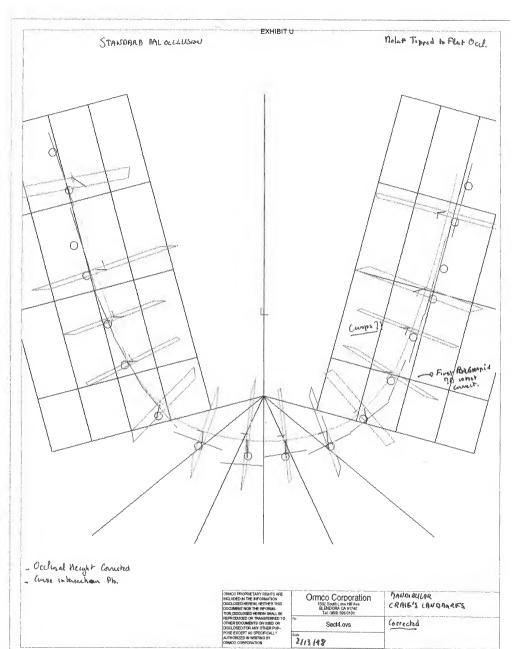
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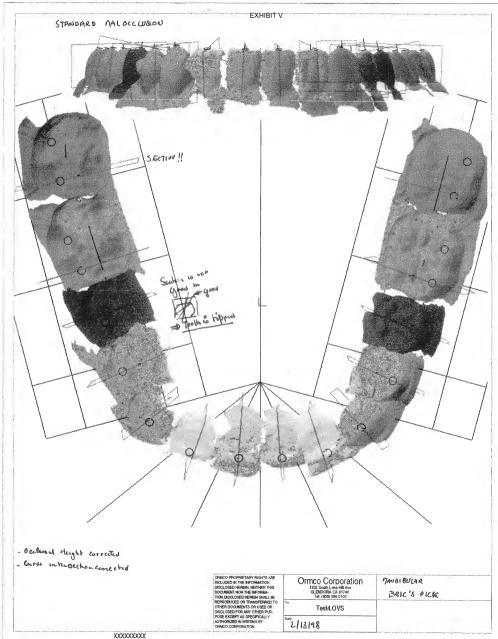
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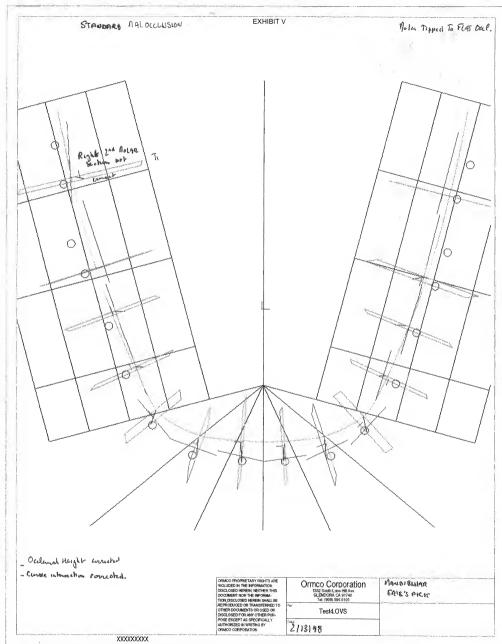
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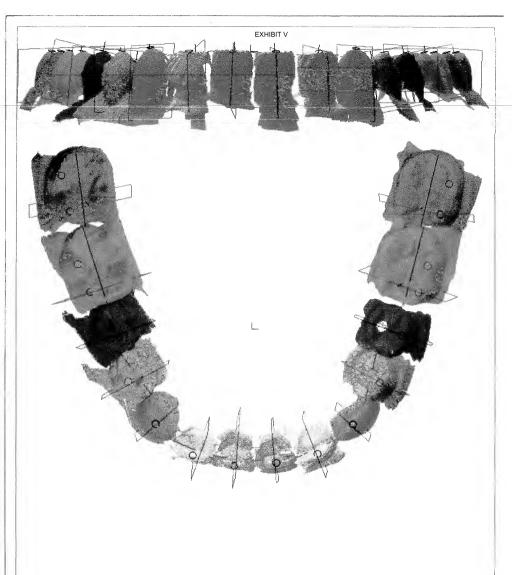
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